descriptive of the disease each drawing delineates. Finally we confess to being sufficient of a bibliomaniac to appreciate most thoroughly the tasteful form in which the book has been issued by its publishers. Good, even elegant binding, thick and softly-tinted paper, broad margins, large clear type, and fine plates, can but excite pleasure in the heart of the lover of books, and he hails the appearance of each new medical work in similar dress with satisfaction, as an index of the progress that is being made in the book-maker's art in our class of literature, and as an evidence that the homely sheep-bound book of our forefathers is happily obsolete.

G. M. L.

## ART. XVIII.—*Daltonism or Colour-blindness.*

1. *Dangers from Colour-blindness in Railroad Employés and Pilots.* By B. JOY JEFFRIES, M.D., Ophthalmic Surgeon Massachusetts Charitable Eye and Ear Infirmary. [Extracted from the Report of the Massachusetts State Board of Health, 1878.] 8vo. pp. 40. Boston, 1878.
2. *Incurability of Congenital Colour-blindness.* By B. JOY JEFFRIES, M.D. *Boston Med. and Surg. Journal*, March 28, 1878.
3. *Le Daltonisme.* MM. J. DELBOEUF et W. SPRING, Professeurs à l'Université de Liége. *Revue Scientifique de la France et de l'Etranger*, 23 Mars, 1878.

OF a large number of publications on the subject of colour-blindness, which have given it quite an extensive literature, those whose titles head this article are the latest that have come to our notice.

It is a subject of much interest from various points of view. As M. Delboeuf well says, "It belongs to physiology as well as to physics, to æsthetics as well as to psychology; nor is it a stranger to philology and history." Added to these, or perhaps rather including them all, it has recently claimed a place in the theory of evolution.

Without undertaking to advocate or to question the "Young-Helmholtz theory," it will be convenient to use it in attempting to state what is meant by colour-blindness. Taking it for granted that the three base colours, red, green, and violet, when combined in various proportions, form the solar spectrum as seen by normal eyes, colour-blindness may be said to be the more or less complete inability to perceive one or more of these colours. As each of these colours enters into the composition of all the colours of the spectrum, it will be seen how complicated the result of this defect must be, and what a difficult thing it is to find out with any degree of precision just what the patient does see. No part of the spectrum is to him exactly what it is to a person with normal vision, and his nomenclature is, of course, at fault; he is "obliged to make use of a dictionary which has not been made for him." Of the missing colour itself he has no conception, and a person completely red-blind, however brilliant or learned he may be, can hardly be said to know what he is talking about when he speaks of red.

Very much the most frequent form of colour-blindness is that for red; that for green is next in frequency; that for blue is rare; while cases are on record of persons with otherwise normal vision who were blind for two of the base colours, or even for all colour. Even when one colour only is involved, the defect may vary indefinitely in degree; indeed, M. Delboeuf inclines to the opinion that no two people see colours exactly alike, that each one has, as it were, a spectrum of his own. The defect may be shown merely by the demand for a greater intensity of illumination for the recognition of a colour. We have met recently with a gentleman who could see only a uniform green in a cherry tree at the foot of his lawn, which to others was "in a blaze of red," with a profusion of fruit, while he had no difficulty in recognizing the red colour of a bed of geraniums near the house.

Colour-blindness is much more frequent than is usually supposed. Dr. Wilson, of Edinburgh, in the examination of 1154 persons, found 5.6 per cent. colour-blind. Prof. Helmholtz admits this proportion; and Dr. Jeffries, among 611 students of Harvard University and the Boston Institute of Technology, found colour-blindness in five per cent. It is believed to be much less frequent in females than in males. The subject of colour-blindness is frequently quite unconscious of the defect; indeed, when it does not exist in a high degree, this is said to be the rule.

The following *résumé* of the observations of Holmgren on this subject is translated from the paper of Delboeuf:—

"It would seem that those affected should be easily detected. Experience, however, proves the contrary. The author has examined the whole personnel of a railroad line, and found that a large number of the employés, though obliged to give attention by day and night to signal colours, had a defective sense without either themselves or others having ever suspected it. Here is the explanation of this strange fact.

"Our senses are directed to the cognizance of the exterior world in a manner entirely practical. Hence it results that objects are invested by us, and that permanently, with qualities that are, at bottom, but our peculiar ways of perceiving. It is thus that a *red carpet* is for us constantly a *red carpet*, even in darkness, even when we are not looking at it. If then we say to a child, this *carpet is red*, he will retain the name, and will apply it correctly every time that he sees the carpet. Now, in fact, it is not only by the colour that he recognizes it, but by a complex combination of qualities, among which the sensation of colour plays but a secondary role. If his colour-vision is defective or not, the child will learn in this manner that the sky is blue, grass green, bricks red, and even if it may happen that, to his eyes, bricks have the same colour as grass, it will never occur to him to confuse these objects and to attribute to one of them a quality that does not belong to it.

"Doubtless Daltonians have no comprehension of certain distinctions established by others; but, after more or less fruitless efforts, the greater number say to themselves that colours offer little problems that they are not called upon to resolve, and think no more of it. But others go further; they persist in finding out the distinctive character of the colours which they confound; they see in it a matter of dimness and intensity of light, acquire a great skill in distinguishing them by this means, and end by deceiving themselves.

"There are nevertheless circumstances in which it would seem that the person must necessarily discover his own defect. It is when he must determine his actions by the colours of objects. This is the case with painters, tailors, and the employés of the marine and railroads. Even here, however, a multitude of causes concur to hide from them continually the anomaly of their visual sense. In the rural districts, among the lower classes, little attention is paid to the colour of objects. If a bucket or a piece of furniture is to be painted, all that is required is that it shall be painted, and that the colour shall be bright; it matters little whether it is red or green or brown. If a garment is to be mended, the essential is that the rent shall be closed, and it is considered a secondary matter whether the patch shall be of the same colour as the rest. The engineer who directs the locomotive is, in the first place, never alone; then, as he knows at what places the signals are generally made, he looks for them and learns to recognize them by the particular intensity of their light: he has thus no reason to suspect his defect. All the colour-blind on the railroads that Holmgren had occasion to inspect persisted in affirming that they had excellent vision: that they distinguished the signals without difficulty; and that they had never committed a blunder."

Attention was first called to imperfections in the colour sense in 1777 by Joseph Huddart's brief description of the cases of brothers named Harris. The subject never received scientific investigation until the famous English chemist, Dalton, who was red-blind, described his own case in 1794. He was persuaded that his vitreous humour must be blue, and directed that it should be examined after his death.

The term "Daltonism" has been for many years almost universally applied to colour-blindness; but, according to Dr. Jeffries, "It is now, however, generally agreed to give up this use of so distinguished a man's name, and, as has been claimed, 'Daltonism' should mean rather the doctrine of indivisible chemical atoms, and 'Daltonian' a believer in such." *Chromatopseudopsie, achromatopsie*, and a number of other hard names have been proposed, but, as they do not express the affection more definitely than "colour-blindness," it seems scarcely desirable to burden the literature of the subject with them.

Dr. Isaac Hays published a paper on the "Impossibility of Distinguishing Colours," in the *American Journal of the Medical Sciences* for August, 1840, and was, we believe, the first to call special attention to the defect as a pathological condition; and in 1845 Dr. Pliny Earle, in the same Journal, reported the singular history of the colour-blindness of five generations of his own family. Comparatively little attention, however, has been given to the subject in this country, and Dr. Jeffries has the merit of being the first on this side of the Atlantic to urge its great practical importance, especially in our railway and marine service.

It is hardly necessary to refer to the fact, so well known to the travelling public, that the use of red and green signals is universal both on land and sea, and that, particularly at night, the proper interpretation of these signals is absolutely the only security against collisions and other accidents. Another fact, not so generally known, but equally evident to those who have given their attention to the subject, is that there are, in every community, a considerable number of persons who cannot distinguish between red and green. One would suppose that the eloquence of these two facts, considered together, would be enough to convince any reasonable mind of the necessity of taking the strictest precautions to exclude such persons from positions where their defect must involve such very grave dangers. This reform, however, has had to contend not only against considerations of trouble and expense and the sacrifice of the interests of the few to those of the many, but against the honest incredulity of those in authority, whose practical experience has seemed to justify their doubts.

As to the manner in which colour-blindness may be concealed even from the knowledge of the person affected, and the fact that railroad employés and others may learn to recognize a signal by the *intensity* of its light without being able to distinguish its colour, we have already quoted the explanation of Prof. Holmgren, of Sweden, who has been more persistent and successful than any one else in urging the importance of this matter. The following practical application of this explanation, by the same authority, is taken from the pamphlet of Dr. Jeffries:—

"Did we not know this we should be greatly astonished to find with what facility a colour-blind railroad employé can distinguish between the red and green flag, and generally call the red, green, and yellow lanterns by their right colour; but it is the intensity of the light, and not the colour, which governs his decision, and *this is the whole secret.* The flags and lanterns have, in fact, usually a constant difference as to intensity. The green flag is to the colour-blind, as also to the normal eye, undoubtedly of the deepest or darkest colour, and the red the most brilliant. As to the lanterns the red-blind always recognize the red light by its being darker than the green, and the yellow by its being clearer or more brilliant than the other two. The green-blind finds also, in his turn, the red more brilliant than the green, and distinguishes it by this. . . . .

"Considering only practically the fact mentioned, and the explanation we have given, we might, perhaps, imagine that colour-blindness had some scientific, but hardly any practical interest, and hence that all the talk that has been made about it in railroad employés in our country was unnecessary, because, as may be said, the colour-blind have often been employed for a long time in railroad service without its being noticed, and without accident or the slightest inconvenience arising; and, finally, that since they can really distinguish the signals (although this is otherwise than by colour) their kind of blindness need not call for any preventive measures. It is thus that a great many persons still reason. We do not stop here to give the testimony of experience on this point in our country. One fact is certain: namely, that colour-blindness in other countries has caused numerous and very fatal accidents. . . . .

"That the situation of the colour-blind in respect to signals may be thoroughly understood, we must here add a few important words on this point. What is the intensity of light? Strictly speaking it is nothing but the force of the impression of the light which our eye receives. This, however, is dependent on two factors: one, the quantity of light radiating from the object observed or reflected from it; the other, the strength or amount to which the eye reacts to this, or, in other words, the sensibility of the subjected visual sense. We may readily understand that both of these factors are extremely variable under the circumstances of the engineer's service. The amount of light which comes to his eye depends naturally on the amount reflected from a coloured object, or which, for example, radiates from a railroad lantern. It is very evident that this quantity may vary from many causes, such as the nature of the illuminating material, and the wick, the colouring matter of the glass, its thickness, the peculiar property of the glass, etc. If a little moisture or smoke, vapour, ice, snow, etc., adheres to the glass the lantern is less luminous. A lantern illuminates more in clear than in foggy weather. All this may give rise to mistakes. But, on the other hand, the sensibility of the eye differs greatly under different circumstances. The nervous apparatus of the eye may, like all other parts of the system, vary in its sensitiveness. The same light is brighter to a healthy eye in repose than to an eye fatigued and weakened. Every modification of the intensity of the light is, however, for the colour-blind *a change in colour.* . . . Ask any superior official of a road if he would be willing to take charge of and run a locomotive, assuming the responsibility, when uncoloured signals alone were permitted, and a feeble light meant *danger*, a medium one *caution*, and a strong one *road clear*. If he says no, tell him that these are just the conditions under which every colour-blind engineer has performed his duties. The absurdity is evident at once."

In a communication to the *Chicago Railway Review*, on "Defective Vision considered in its relation to Railroad Management," Mr. Thomas F. Wilson says that he has kept record of accidents by land and water for some years, and gathered all the information he could in reference to them, and is convinced that a large proportion of them were the results of colour-blindness. The comparatively small number of accidents from this cause he attributes to the "high average intelligence and acquired cautiousness of engineers and pilots as a class," and says they acquire a "sort of instinct" that guides them. He tells of an engineer who was continually making narrow escapes, until colour-blindness was finally proved and acknowledged. This man afterwards declared that he had had nothing definite to base his actions upon, but had been guided entirely by this caution and instinct.

The testing for colour-blindness is by no means so simple a matter as it might at first sight appear. It would be quite useless, for instance, to test an engineer with the flags and lanterns with which he has become familiar. Any test necessitating the naming of a colour is imperfect; a person may name the colour of an object correctly because he has heard that name applied to it, or has associated the name with some other quality of the object, though he has no conception of its colour.

Even the congenitally blind can usually give correctly the colour of the sky or of foliage. A person interested to conceal his defect might even intentionally deceive by making ingenious guesses founded on the intensity of the reflected light, or upon some other properties of the object. An amusing instance of the latter is related by Mr. Chapin, principal of the Pennsylvania Institution for the Blind. One of his former pupils, who was stone blind, asserted in the presence of a number of gentlemen that he could distinguish colour by the touch. When challenged to the proof, he passed his hand down the front of their coats and pronounced one blue, another black, and another gray; in each case correctly. The first coat had metal buttons, the second was of close texture and smooth surface and had covered buttons, and the third he recognized, from the cut of the collar, to be the coat of a Quaker.

A number of different tests have been proposed; the simplest and best is that used more than twenty years ago by Wilson, of Edinburgh, and recently revived by Holmgren. The person examined is directed to match different coloured worsteds. It is now very generally adopted in Europe.

As to the practical results of the agitation of this subject, Dr. Jeffries informs us that the Swedish, Russian, and Bavarian governments have ordered all persons connected with the railroads to be tested for colour-blindness; in Italy all railroad employés are subjected to rigorous examinations; and investigations have been, or are being made, on an extensive scale, in France, Belgium, Holland, Denmark, and Finland. In Finland, of 1200 employés examined, 60 were found colour-blind. Not much progress has been made in England, though Prof. Tyndall has added his warning to that given strongly twenty years ago by Wilson; but the subject is being discussed there.

In this country, so far as we know, absolutely nothing has as yet been done. It is to be hoped that Dr. Jeffries's pamphlet may direct the attention of those in authority to the very great importance of this subject.

The article on "Incurability of Congenital Colour-blindness" is a criticism on the views of Dr. Favre, of Lyons, who has been the only authority to advocate the possibility of curing it by systematic exercise of the eye with colours. It is shown that Dr. Favre has confused the knowledge of the *name* of a colour with the *ability to perceive* the colour. The author is confident that a colour-blind person can no more be taught to recognize the colour in which his spectrum is deficient than he can be taught to hear a note above or below the vibratory scale of his ear.

Those who desire to study the subject of colour-blindness will be thankful to Dr. Jeffries for the very copious and complete bibliography that he has furnished.

Delboeuf is himself a "Daltonian," and, in endeavouring to verify the Young-Helmholtz theory, it occurred to him that it might be possible that the atrophy of the red-perceiving elements was only relative, in the sense that their action was masked by the preponderating action of the two other elements. Supposing this to be the case, it would follow that by interposing between the eye and external objects a transparent reddish substance he could "re-establish the equilibrium," since, in this way, the green and violet rays would be in part extinguished.

One of the greatest difficulties in the way seemed to be to determine the exact degree of coloration to be used, and, to overcome this, he decided upon a coloured liquid inclosed in a glass prism. This gave a degree of colour increasing gradually from angle to base. The colouring matter selected was a solution of fuchsin (magenta). The effect of looking through this, the author assures us, was marvellous. Not only did the colours which he habitually confounded—blue, carmine, and violet on the one side, and scarlet and brown on the other—appear decidedly different, but scarlet particularly assumed a brightness before unknown to him; while before it had appeared dull, it now became brilliant ("flamboyant et éblouissant"). The experience of a number of other Daltonians, upon whom he experimented, was the same.

The author claims that these experiments, if they do not entirely subvert the Young-Helmholtz theory, at least prove that the colour-blind owe their peculiarities of vision not to an atrophy, more or less complete, of the red-perceiving elements, but rather to a special susceptibility to the green and violet rays, or, more exactly, to the colour complementary to fuchsin.

It would seem, at first thought, that any red substance should produce the same effect as fuchsin, and that this effect could not be produced by any substance of another colour; but this was found not to be the case. Aniline violet, and eosine, which is orange, also corrected his Daltonism, though in a less degree; while a piece of glass, coloured red by oxide of copper, produced no other effect than to deaden all the colours except red. This proved that the correction-property of the fuchsin was not dependent upon its colour; and when this substance was analyzed by the spectroscope, it was found that it extinguished the green region of the spectrum, and it only. The dark band was sharply defined, particularly on the side next the yellow.

Spectroscopic analysis of aniline violet and of eosine gave the same result, except that the dark band was less sharply defined, and its position was somewhat different. But the glass coloured with oxide of copper obliterated all the colours except the red.

The author thinks that if he has not completely proved, he has at least made it probable, that it is the presence of the whole or a part of the green (which may be suppressed by fuchsin) that renders certain eyes insensible to the complementary colours.

The next step was to attempt to produce Daltonism artificially in normal eyes by suppressing or enfeebling all the light but the green. After experimenting with a number of substances without success, chance again came to the rescue and threw chlorate of nickel in his way. Through a four per cent. solution of this substance, M. Spring, whose vision is normal, found violet to become blue, red to identify itself with brown, and nature to assume a dull and uniform aspect. The effect of this solution on the solar spectrum was to reduce it to a green band corresponding exactly to the gap that the fuchsin had made in it.

Daltonism, produced artificially by chlorate of nickel, was corrected by fuchsin; and natural Daltonism, corrected by fuchsin, was restored by chlorate of nickel.

As a physiological hypothesis, the author suggests the application to colour-vision of the "Theory of the natural equilibrium of the organs of sense," which he has advocated elsewhere, and which he calls the "Psychophysic law."

According to the wave theory of light, the different colours of the spectrum depend upon the different rates of vibration of the ethereal waves. If the number of vibrations for green be represented by 9, blue, indigo, and violet will be 10, 11, and 12; and red, orange, and yellow will be 6, 7, and 8. The retina is compared to a membrane set to a certain tone, but capable of being stretched or relaxed under the action of external forces; just as the vocal cords, though they manifest a certain preference for a special octave, can vibrate in unison with octaves above or below it. If the natural tension of the retina be supposed to be adapted to green, the sensation of green will result from the characteristic vibration of the membrane.

Designating by 0 the natural equilibrium of the retina corresponding to the number 9, which represents the number of vibrations for green, the series, beginning with violet and ending with red, may be expressed by $+3+2+1.0.-1-2-3$.

> "But, like all elastic substances, the retina tends to maintain itself at 0; it is not without a certain resistance that it takes the movements $+1$ and $-1$; its repulsion is more marked for the movements $+2$ and $-2$; and much more decided still for the movements $+3$ and $-3$. Its inertia will be, in each case, reinforced by the presence of green rays which exist, in greater or less quantities in all complex colours. For the moment that the retina feels their presence, it will obey them, and its capacity to obey a different force will be diminished in proportion as the effects of this latter force are in part masked by the preponderating effects. Nevertheless, in normal vision this diminution will never go so far as to prevent the retina from receiving, or, if you will, from perceiving the extreme movements. But with Daltonians this is not the case; with some, it refuses to yield itself sufficiently to the movements $+3$ and $-3$; with others, to the movements $+2$ and $-2$; finally, there are, perhaps, some where it will not receive even the movements $+1$ and $-1$. Hence we can readily conceive why these Daltonians are corrected, either by the interposition of fuchsin, which checks the auxiliary, or by the projection of purple light, which brings support to the insufficient forces."

This theory is ingenious and entertaining, but fanciful, and, perhaps, somewhat crude; indeed, the author himself speaks of it as merely a rough sketch, and excuses his departure from what he says might be a becoming reserve by the hope that his theory, even if false, may assist in directing others in the right path. At all events, he is on debatable ground where any one may build a theory, and hold it if he can.

The question naturally arises, supposing these views to be correct, why "Daltonians" should not distinguish the green of the spectrum. The author says this fact is analogous to the well-known phenomenon that artificial light (which has an excess of yellow) makes yellow objects appear white:—

> "Any kind of light, when it is the only light, tends to appear white. It is thus that the photographer, in his chemical cabinet, which is lighted only by yellow light, does not see it yellow but white; it would be the same if the glass were blue or red. . . . With the natural Daltonian, as with him whose eye is submitted to general excitation by green light, the green may be unperceived or produce the effect of white light."

The last section of the paper relates to the possibility of curing Daltonism. Of this our author is by no means hopeless. He tells us that, after having spent much time, during several months, in experimenting with the fuchsin, he noticed a decided change in the colouring of a favourite picture. Some time afterwards, while walking in the street at night, he distinguished the red light of a lantern placed, as a warning, over a breach in the culvert; and found that he could distinguish the red colour of a railway light which, lately, had not appeared to him different from an ordinary gas flame. He is here, again, ready with a theory, or rather considers this experience a confirmation of the theory already proposed. The fuchsin overcomes certain resistances by arresting the rays of light whose property it is to encourage and maintain these resistances, and he had subdued these so often in his frequent and long-continued use of the fuchsin that the nervous element of his retina had, as it were, acquired new habits and yielded more readily to the force of luminous impulses.

Delboeuf's experiments with coloured media remind one of Liebreich's London lecture on Turner and Mulready. Liebreich took the ground that the excessive blue in the later pictures of Mulready, who continued to paint after he was seventy years of age, was due to yellow degeneration of the crystalline lens; and maintained that this excess of blue could be neutralized, and these pictures could be restored to the harmony of the artist's earlier productions, by looking at them through a glass slightly tinted with yellow.

The observations of M. Delboeuf are new and interesting, and will, we believe, prove useful; for, though he is evidently not free from the bias of a favourite theory, and perhaps avails himself rather freely of the "scientific use of the imagination," he has worked ably and honestly and with great ingenuity in a difficult field of study, and his labours can hardly fail to, at least, excite renewed interest in this important subject.

It is one of those subjects which, though they may appear simple enough to the superficial glance, expand indefinitely as you penetrate them more deeply, and become more intricate the more you study them. It is involved in the wide and unsettled subject of colour vision, concerning which scientific opinion seems to be just now in a state of transition, and must remain in doubt so long as does the latter. We must have a theory of colour-vision before we can have one of colour-blindness.

Those who have the strongest faith in the "potency and promise" of the retinal red, discovered by Boll, will have most hope of the final settlement of these questions on a photo-chemical basis. The theory that all the phenomena of visual impressions are the result of changes effected in this colouring matter by the action of light is most attractive, and may contain the germ of the future solution of the whole matter. Its present status, however, is scarcely more than suggestive.

The question seems even more complicated when we remember that the sensation of light and the sensation of colour are the result of two distinct functions. In some observations recently communicated to the French Academy of Sciences by MM. Landalt and Charpentier, it was shown that "the luminous sensation is the reaction, simple, primitive, essential, constant, of the visual apparatus; the sensation of colour is a reaction, secondary, inconstant, variable, according to the point of the retina considered, and according to a number of experimental conditions." The chromatic sensibility may vary independently of the luminous, and the luminous may vary under certain conditions, while the chromatic remains constant. Indeed, these conclusions do little more than formulate familiar facts of every-day experience; the colour-blind may have more than the average acuteness of vision for form, and we not unfrequently meet with persons who have not vision enough to go about alone, but who can still distinguish colours.

A large portion of the retina is normally colour-blind, the whole spectrum is seen only in the central portion around the macula lutea; beyond that the perception of red disappears, then that of green, and finally, at the periphery, the sensibility to blue only remains. According to Dobrowolski, the limit for the sensibility for red is 80° from the fovea, for green 95°, and for blue 105°, the extent of the visual field. This is on the inner side of the retina, on the outer side the limits are 65°, 73°, and 77°. These conditions are frequently modified by disease.

According to Geiger, Magnus, and others, what would now be colour-blindness was the normal condition of our remote ancestors; the sensibility to colours enjoyed by the present generation is the hereditary result of education prolonged through many generations; in other words, the colour sense has been developed by a process of evolution. This theory, advanced some years ago by Geiger, who has since died, has been recently developed at considerable length by Hugo Magnus, Professor of Ophthalmology in the University of Breslau. Magnus divides the colours of the spectrum into three classes: those richest in light, red, orange, and yellow; that which has a medium degree of luminosity, green; and those which are feeblest in light, violet, indigo and blue; and argues ingeniously and learnedly to show that the advancing ages acquired each in turn. He maintains that primitive man possessed only the sense of light, that red was the first and violet the last colour to be recognized, and that it is not impossible that our descendants may acquire the appreciation of colours that escape the present generation. Geiger stated that the Rig-Veda contained no mention of green, blue, or violet, and similar statements have been made of the Koran and the Bible. Magnus says that Xenophen saw only three colours, red, purple and greenish-yellow, in the rainbow, and that the Homeric poems belong to the same colour-period, as they confound green with yellow. The mention of the Homeric age brings to the front Mr. Gladstone, who fully adopts the views of Magnus, and shows that Homer perceived red and yellow, but confused green with yellow and blue with black.

We refer to this theory, as briefly as possible, merely because it has been extensively discussed, both in and out of the profession, and forms an interesting, if not very important, chapter in the literature of our subject. The objections to it are numerous and obvious. As the proofs adduced are entirely of an historical character, there is the probability of confusing the names of colours with the colours themselves, and, therefore, the means of expression with the power of perception. M. Delboeuf has called attention to the fact that we, even now, have no special designations for odours, and our nomenclature for the various and precise sensations of hearing is very incomplete. Sterner scientists have objected to going to poets for scientific data, even leaving out of consideration the possibility that Homer may himself have been colour-blind. The assertions in reference to the Rig-Veda and Koran are, so far as we know, unchallenged, but it is stated in a recent communication to the Philadelphia *Ledger* (July 26), that blue is mentioned nine times and green or greenish forty times in the Bible. Looking back beyond man on the scale of development, numerous experiments have demonstrated the recognition of colours by the lower animals; not to go more deeply into this subject, any farmer's boy can testify to a lively appreciation of red on the part of an excitable bull.

M. Javal has taken up the gauntlet, and, avoiding any imputation upon his progressiveness, has boldly accepted the theory of evolution, and pushed it to a conclusion diametrically opposite to that of Magnus. He says there is no reason to suppose that the longer but less numerous waves of the colours towards the red end of the spectrum should excite the retina more powerfully than the shorter but more frequently repeated waves at the other end. On the contrary, the analogy of hearing points in the opposite direction. (The fact that while the perception of red is confined to a circle of the retina around the macula, blue is perceived throughout the whole visual field, may be of interest in this connection.) It is known that the eye is not an achromatic instrument, and that, therefore, if the less refrangible red rays are focussed accurately upon the retina, the more refrangible violet rays must be focussed in front of it, and fall upon it in circles of diffusion. The eye, therefore, accommodates itself for an intermediate distance so that the red and violet circles of diffusion may be made too small to create confusion.

If evolution should add another colour beyond the violet, accommodation would become more difficult, the circles of diffusion larger, and vision less accurate. This would be to sacrifice the useful to the agreeable. If the coloured rays of the spectrum are intercepted, the invisible ultra-violet rays become visible. These rays are suppressed, or rather neglected, in the interest of accurate vision, as every visual sensation is, that would be injurious to the perception of external objects. "Then, contrary to the views of M. Magnus, *progress*, in the domain of vision, should rather consist in restricting than in increasing the extent of the scale of colours. *Pourquoi pas?*" Why not? indeed, just as we have got rid of the tail of our fathers. G. C. H.

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ART. XIX.—*Visions: a Study of False Sight (Pseudopia).* By EDWARD H. CLARKE, M.D. With an Introduction and Memorial Sketch by OLIVER WENDELL HOLMES, M.D. 16mo. pp. 315. Boston: Houghton, Osgood & Co., 1878.

THIS book comes before us under remarkable circumstances. The author, who recently died at the age of 57, had reached a foremost place in his profession and in the respect and consideration of the community in which he lived and died. Few men have combined in a higher degree a well-earned professional eminence with large general culture, and morals and manners that recalled the best type of the gentleman. With a large practice, studious habits, and habitual association with thoughtful men, he was well prepared to ponder the questions which his profession was constantly presenting, in a purely philosophical spirit. If he made no great achievements in original investigation, he had the scarcely less valuable merit of measuring the claims of others with profound insight and a judicial impartiality. His *Sex in Education* and *Building of a Brain* are admirable examples of a broad observation, keen analysis, and dispassionate judgment. In the very maturity of his powers, with many more years before him, apparently, of an honorable career, he became the victim of a pain-